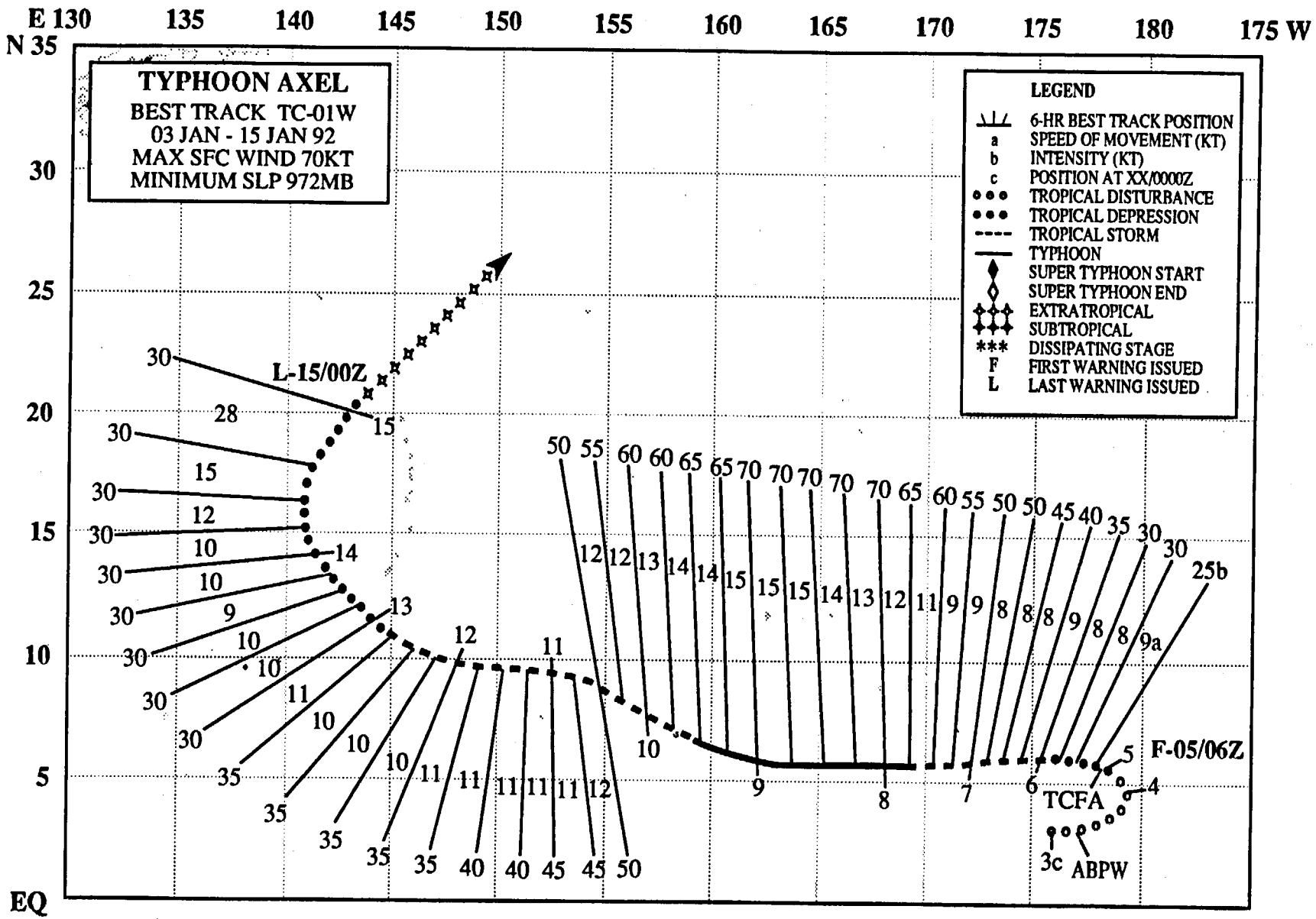
TYPHOON AXEL
BEST TRACK TC-01W
03 JAN - 15 JAN 92
MAX SFC WIND 70KT
MINIMUM SLP 972MB
LEGEND
6-HR BEST TRACK POSITION
a SPEED OF MOVEMENT (KT)
b INTENSITY (KT)
c POSITION AT XX/0000Z
TROPICAL DISTURBANCE
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON
SUPER TYPHOON START
SUPER TYPHOON END
EXTRATROPICAL
SUBTROPICAL
*** DISSIPATING STAGE
F FIRST WARNING ISSUED
L LAST WARNING ISSUED
E 130 135 140 145 150 155 160 165 170 175 180 175 W
N 35 30 25 20 15 10 5 EQ
L-15/00Z
F-05/06Z
TCFA
ABPW

# TYPHOON AXEL (01W)

## I. HIGHLIGHTS

Typhoon Axel was the first significant tropical cyclone to occur in 1992 in the western North Pacific. It developed in January in conjunction with an equatorial west wind burst to the east of New Guinea along with two other tropical cyclones — Betsy (11P) and later Mark (12P) — in the Southern Hemisphere. Axel's early intensification at a low latitude proved particularly damaging to the Marshall Islands.

## II. TRACK AND INTENSITY

Stronger than normal low-level westerly winds along the equator were noted east of New Guinea when Tarawa (WMO 91610) in the Gilbert Islands reported 28 kt (14 m/sec) gradient-level winds at 011200Z, 37 kt (19 m/sec) gradient-level winds at 020000Z, and later, at 030000Z, Banaba Island (WMO 91533) 300 nm (555 km) to the southwest of Tarawa reported surface winds of 30 kt (15 m/sec). These increased winds and an area of maximum cloudiness persisted in the area, as twin cyclones began to form. Axel was to the north and Betsy (11P) to the south of the equator. The evolution of these twin cyclones, and later a third, Mark (12P) located to the west of Betsy (11P), is graphically illustrated as cloud silhouettes in Figure 3-01-1. The persistent convection, which was to become Axel, was first mentioned on the Significant Tropical Weather Advisory at 030600Z. As the equatorial westerly winds died down, the convection began to consolidate around the twin disturbances. This prompted the issuance of a Tropical Cyclone Formation Alert on Axel at 050030Z, and the first warning at 050600Z. Strong upper-level divergence over the area enhanced development of the cloud system and Axel (Figure 3-01-2) attained tropical storm intensity based on Dvorak intensity estimates at 060000Z just before slamming into the Marshall Islands. Later, at 070000Z, an 85 kt (44 m/sec) ship report from the SV Cherokee became the basis for an upgrade to typhoon intensity. (In post analysis, comparison of the 85 kt (44 m/sec) report with observations from the nearby islands of Majuro (WMO 91376), Mili (WMO 91378), Jaluit (WMO 91369) and Ailinglapalap (WMO 91367) caused the SV Cherokee's to be questioned.)

By 8 January, Axel and Betsy (11P) were both at typhoon intensity and the distance between the two was steadily increasing with Axel headed west and Betsy (11P) south. After Axel reached a peak intensity of 70 kt (36 m/sec) at 080000Z, the typhoon passed just north of Kosrae and Pingelap (Figure 3-01-3) in the eastern Caroline Islands. Continuing to track south of the subtropical ridge axis and westward towards Guam, the typhoon weakened due to increasing vertical wind shear. As a consequence, JTWC downgraded Axel to a tropical storm at 091800Z, shortly after the cyclone passed 15 nm (30 km) north of Pohnpei (WMO 91348), where a maximum sustained winds of 30 kt (15 m/sec) and a peak gust to 48 kt (25 m/sec) were reported. Six hours after being downgraded to a tropical depression at 130000Z, Axel passed 90 nm (165 km) to the southwest of Guam. The tropical cyclone recurved a day later. As Axel was transitioning to an extratropical low and accelerating into the mid-latitude westerly flow, JTWC issued the final warning on the system at 150000Z.

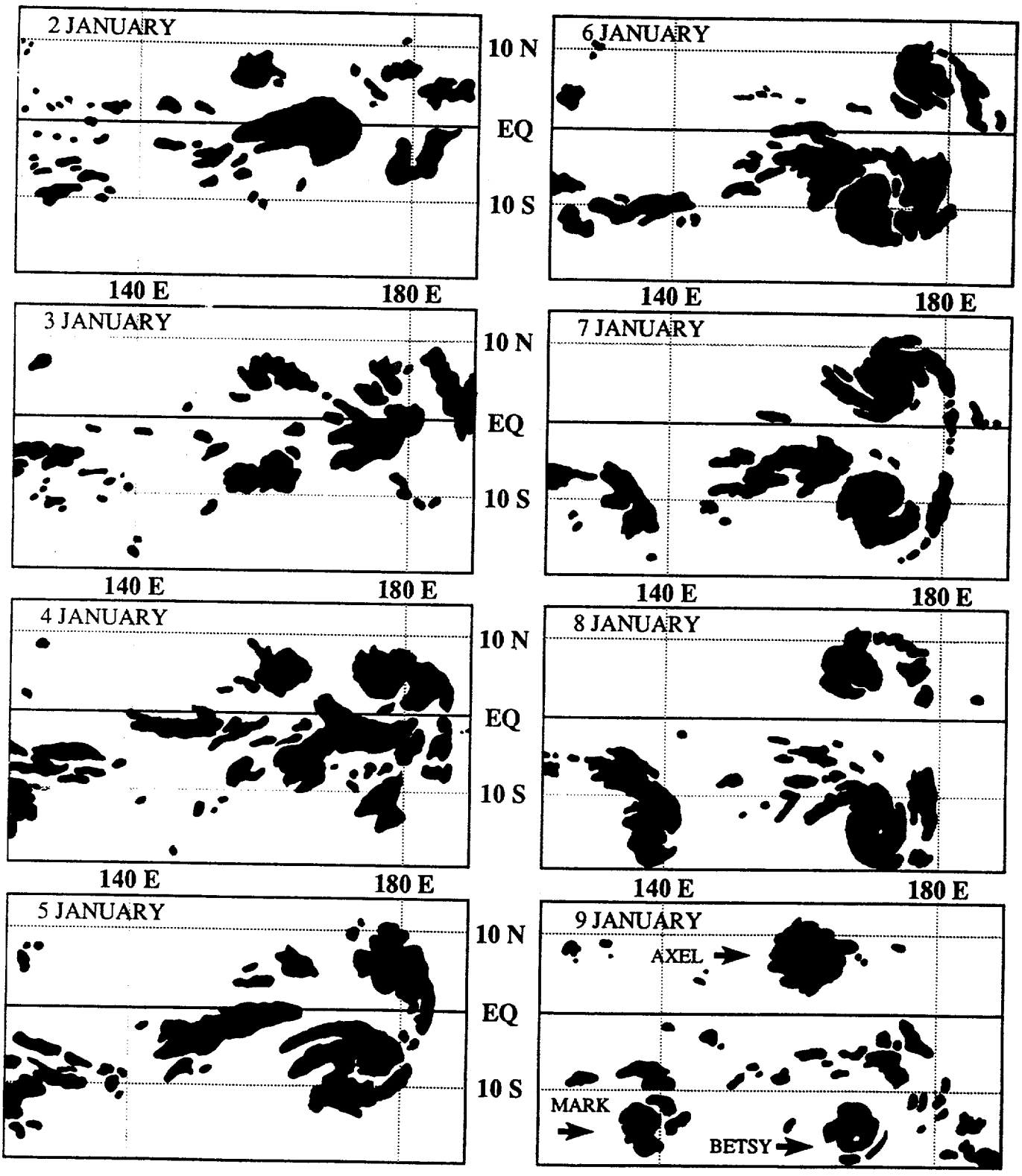


Figure 3-01-1. Cloud silhouettes for the period 2 to 9 January show the development of Axel, Betsy (11P) and later, Mark (12P). As the equatorial convection decreases, the cloudiness consolidates in the twin cyclones in opposite hemispheres.

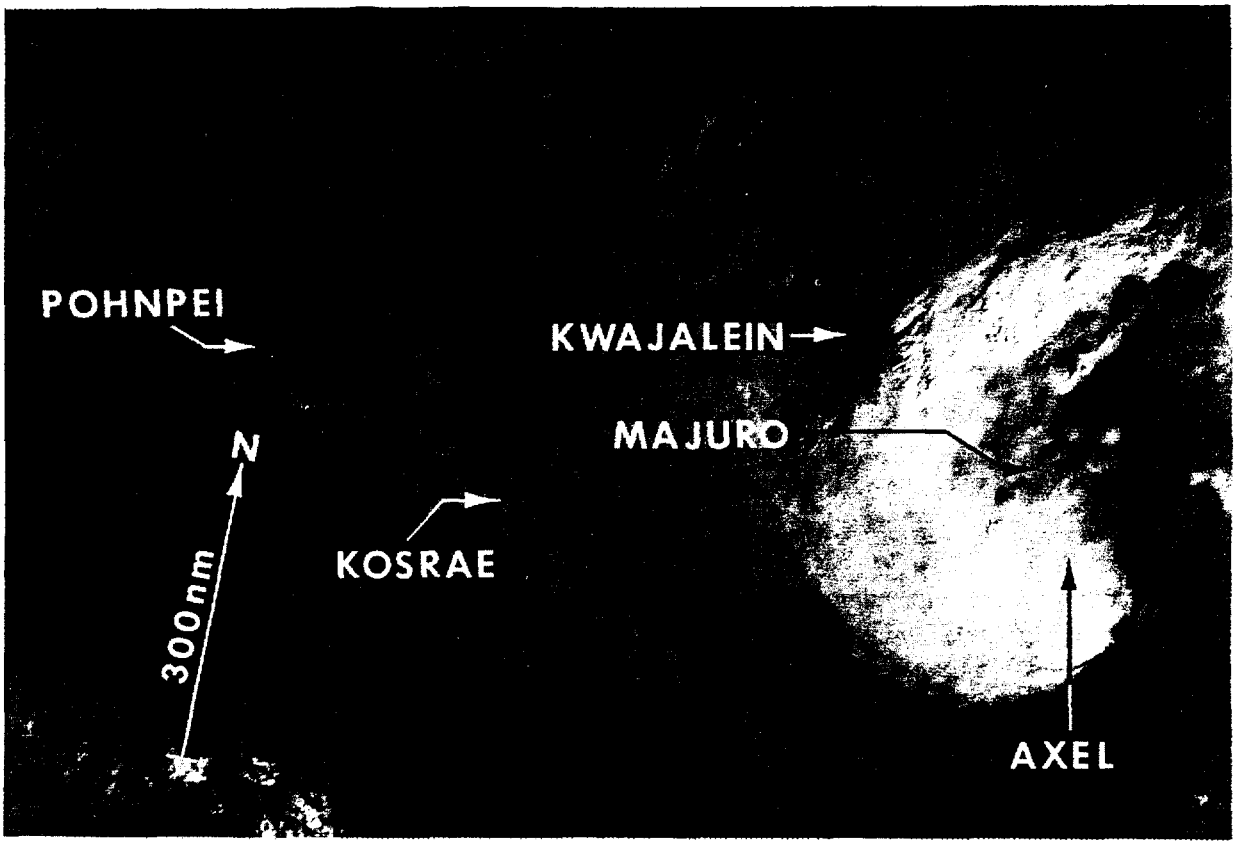


Figure 3-01-2. Axel's convection coils up as the tropical cyclone intensifies over the Marshall Islands (062211Z January DMSP visual imagery).

III. FORECAST PERFORMANCE

The overall mean track errors were 93 nm (172 km), 152 nm (282 km), and 183 nm (339 km) for the 24-, 48-, and 72-hour forecasts respectively. However, JTWC forecasts for a straight runner to the west were longer than needed resulting in larger forecast errors near the point of recurvature where there was a question as to where, or when, a break would appear in the subtropical ridge to allow Axel to track northward.

With regard to the intensity, the initial forecasts based on the development of twin cyclones and strong upper-level divergence, and discussed in the first several prognostic reasoning messages, verified well.

IV. IMPACT

Axel created havoc in the Marshall Islands. In the tropical cyclone's wake, the Federal Emergency Management Agency (FEMA) provided more than two million dollars to over 1300 people requesting assistance on Majuro and four other atolls. Axel washed out airport runways, ruined water reservoir systems, ruined crops and vegetation, and left hundreds of people without roofs over their heads. Mili, the easternmost atoll to be affected, took a direct hit. Houses were blown down and many trees and crops were lost.

Majuro (WMO 91367) experienced peak gusts of 46 kt (24 m/sec) and a low pressure of 997.0 mb as Axel passed 75 nm (139 km) to the south. Unfortunately for Majuro, Axel's closest point of approach coincided with high tide. The high surf, estimated to be in the 13 to 16 foot range on top of the high tide, broke pipes and washed sand, coral rock, and debris onto the island's runway which doubles as a water catchment system and provides almost 90% of the fresh drinking water. Despite the fact that almost 10 inches (254 mm) of rain from Axel fell in a 24-hour period, salt water contaminated most of the water supplies on the island. Sanitation became an immediate problem due to water wells, tanks and toilets being damaged by Axel's passage. The airport was closed for five days while bulldozers were used to clear off the larger debris. The south shore reefs were damaged when huge chunks of coral were ripped out and rolled across the reef. Trees, brush and other debris from the land washed onto the reefs adding to the loss. On land, food crops were ruined by the wind and flooding.

Then, Axel passed across Jaluit Atoll and over four feet of water covered most of the main islands. The strong winds deposited rocks and coral debris on runway and washed away portions of airstrip. Additionally, over one half of the outhouses were destroyed, resulting in serious health concerns for the islanders. Farther north, Kwajalein Atoll, 170 nm (315 km) north of track, experienced maximum sustained winds of only 25 with gusts to 35 kt (10 G 18 m/sec) and reported no damage or injuries.

In the eastern Caroline Islands, Kosrae (WMO 91356) which was 40 nm (75 km) south of track experienced maximum sustained winds of 65 G 80 kt (33 G 41 m/sec) resulting in severe crop losses, trees and vegetation damaged, and some wooden and tin-roofed structures destroyed. Just south of track, Pingelap (Figure 2) and Mokil atolls located east of Pohnpei had their airstrips 60% damaged by the storm surge and the runways were closed for months afterward for repairs. Some wood and tin roofed structures were destroyed. An estimated 50-60% of the small vegetation, such as bananas, was lost, plus some large coconut and breadfruit trees uprooted. As Axel passed 15 nm (30 km) north of the Pohnpei, the island's electrical power was knocked out for 8 hours and houses and building in low-lying areas flooded. Banana and breadfruit trees suffered extensive damage. The storm surge was estimated at 15 feet on the offshore islands and 9.73 inches (247 mm) of rain was recorded in a 24-hour period as the cyclone passed. And finally, Axel was weakening as it passed 90 nm (170 km) southwest of Guam, where no damages or injuries were reported.

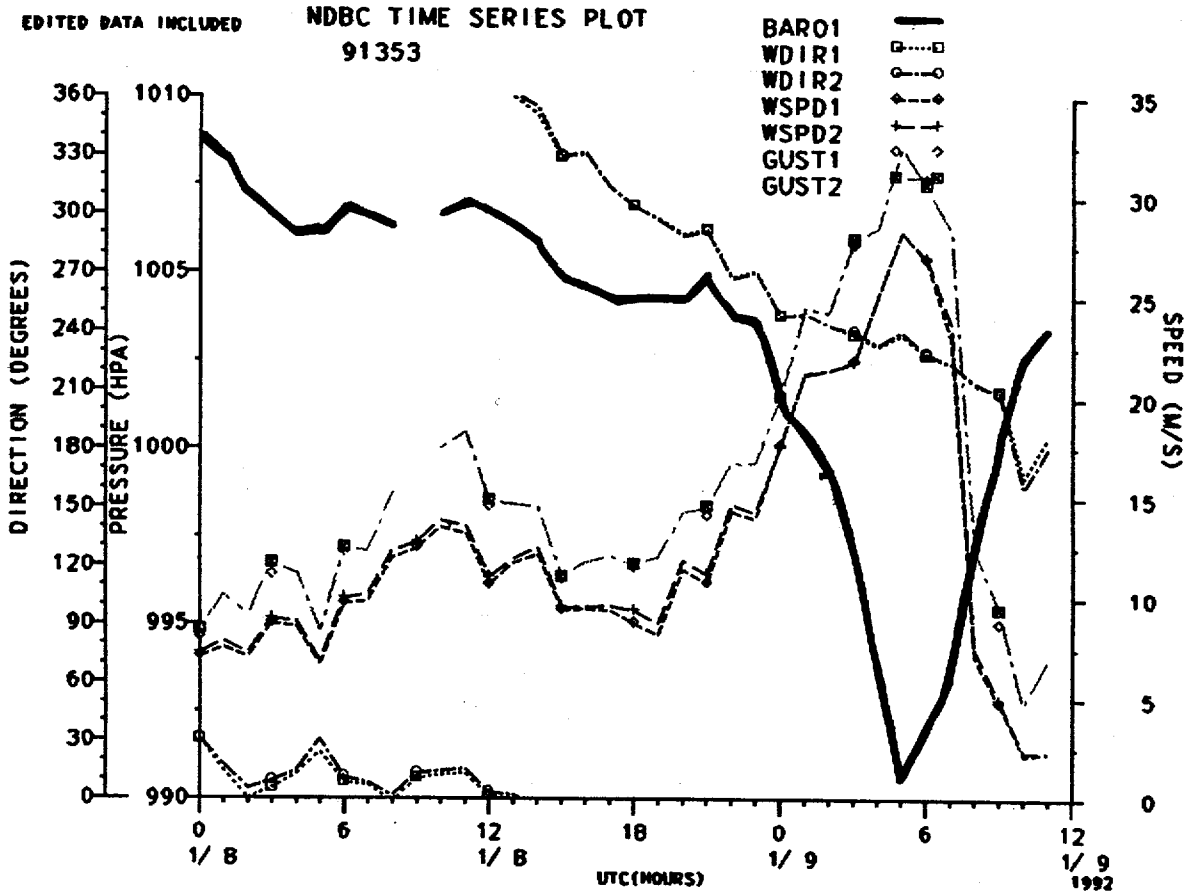


Figure 3-01-3. The Pingelap AMOS (WMO 91353) time series plot courtesy of the National Data Buoy Center shows surface winds gusting to 33 m/sec (64 kt) from the northwest and a minimum pressure of 991 mb at 090500Z as Axel passes by to the north.